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ABSTRACT

Induction programs play a critical role in the development of professional educators. These programs support beginning teachers as their preservice ideology is challenged and as they experience constraints in working in a new school climate. While induction programs are a necessity for all beginning teachers, science teachers need carefully crafted programs that meet their unique needs. This paper discusses the research regarding beginning science teachers, and discusses areas that are essential to consider when induction programs are developed for beginning secondary science teachers. (Contains 37 references.) (Author)

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Induction Programs for Science Teachers: What the Research Says

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The dialogue surrounding teacher induction has increased substantially in the last 20 years (Huling-Austin 1990). Contributors to this discussion include educational researchers who are exploring induction programs and beginning teacher development, policy makers who are calling for the development of induction programs, and professional development specialists who are creating and disseminating programs for beginning teachers. However, this conversation is not new; educators were discussing the induction process and possible programs in the early 1900s. John Hall (1913), for example, authored a paper in *The Twelfth Yearbook of the National Society for the Study of Education* about a University of Cincinnati program in which teachers were supervised during their teacher education program and throughout their first years of service. The program was administered by the College of Teachers and entailed cooperation between the city's public school system and the local university. While current conversations about beginning teachers are similar to those of over 80 years ago, they are also proposing new directions for induction programs.

The recently released Glenn Commission Report, *Before It's Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century* (National Commission on Mathematics and Science Teaching for the 21st Century 2000), emphasizes the importance of fostering the development of beginning mathematics and science teachers. In Goal 3 of the report, the authors call for the establishment of focused induction programs for mathematics and science teachers that acclimate the teachers to the profession, create formal mentoring relationships, and introduce teachers to inquiry groups. The intention of this goal is

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to improve the environment in which beginning teachers work, thereby retaining teachers and promoting teaching as an attractive career choice. Ingersoll (2001), in a comprehensive review of data on teachers, echoes this progressive stance by concluding that more attention should be given to decreasing the demand for teachers than to increasing the supply of teachers.

As university educators and district staff development specialists develop alternatives for beginning science teachers in response to national directives, they will consult relevant educational research in the area of induction. The intention of this chapter is to share important studies in this domain. It begins by summarizing research relevant to beginning science teachers, with a focus on their cognitive and behavioral development. After this overview, implications are drawn regarding the development and enactment of induction programs for science teachers. The chapter concludes with comments about the potential and importance of science-based induction programs.

Beginning Science Teachers

As teacher educators develop programs for beginning teachers, they will consult the literature in order to understand this unique phase in the teacher development process. Some educators will explore literature that describes teacher development stages, and others will review research that discusses the behavioral and cognitive development of beginning teachers. While these literature bases offer different perspectives regarding new teachers, they ultimately give direction in the design of induction programs. Specifically, they direct the framework of the program by revealing essential knowledge that supports the process, appropriate strategies to use, and interpretations of the context in which beginning teachers work. Loucks-Horsley et al. (1998) note that these elements are vital in planning effective professional development programs.

Research discussing the development of science teachers has traditionally fallen into the domains of preservice or inservice education. This has not gone unnoticed in the science education community. During the last decade, science educators have acknowledged the lack of research in the area of induction and have called for additional studies in this domain (Anderson and Mitchener 1994; Adams and Krockover 1997). While the education community addresses this void, there are still informative studies that can guide educators' understanding of beginning science teachers. Fuller and Brown (1975), for example, describe the process of teacher development in stages. In the first stage, teachers have concerns for themselves, which entails a focus on adequacy and survival in the classroom. As they progress to the task stage, they attend to the methods, materials, and skills that they use in their classes. In the final stage, they have concerns about the impact of their instruction on students. In contrast, Bell and Gilbert (1996) describe science teacher development as consisting of social, personal, and professional aspects. Social development involves progressing from individual to collaborative studies of instructional practice. Personal devel-

opment entails moving from accepting problems with one's teaching situation toward feeling empowered to rectify those problems. Professional development encompasses learning and incorporating new instructional practices in the classroom. While these studies are two among many, they clearly provide models that can be used to guide the development of induction programs.

Research regarding the problems of beginning science teachers is, to a great extent, in agreement. Issues related to classroom management and distinct qualities inherent in science instruction are salient among several studies. Adams and Krockover (1997), for example, report that beginning science and mathematics teachers have concerns about classroom management, classroom assignments, curriculum development, time management, and the presentation of content. Their non–subject-related findings were similar to those of Veenman (1984), who conducted a comprehensive review of studies about beginning teachers and found that classroom discipline, motivating students, and dealing with individual differences in the classroom were new teachers' most pressing concerns. Emmer (1986), in a study of the practices of first-year teachers, concluded that beginning science teachers adhered to traditional practices because of the nature of science teaching, the variety of tasks they encountered, the large number of preparations, and the scarcity of established curriculum guides.

Researchers note that the unique constraints experienced by beginning science teachers are often a result of the disparity that exists between their teacher-training programs and the reality of the classroom (Loughran 1994; Wubbels et al. 1982; Veenman 1984). Proposed solutions to this experienced disparity have focused on increased independent instruction during student teaching (Koestsier and Wubbels 1995) or extended and more meaningful field experiences (McIntyre, Byrd, and Foxx 1996).

Research on the beliefs and practices of beginning science teachers has revealed the developing nature of their practices. It is acknowledged that teaching beliefs directly influence a teacher's classroom instruction (Richardson 1996). This implies that beginning science teachers need teaching beliefs that are conducive to inquiry instruction. Unfortunately, the teaching beliefs of beginning science teachers are not stable or well defined (Brickhouse and Bodner 1992; Simmons et al. 1999); as a result, these teachers often fluctuate between using student- and teacher-centered approaches. Simmons et al. (1999), through interviews and videotape analyses, found that science and mathematics teachers in their first and second years were likely to demonstrate a disparity between their beliefs and practice. By the third year, however, beginning science teachers demonstrated more alignment between their beliefs and practices toward either student- or teacher-centered approaches. Kagan (1992), in a review of studies on preservice and beginning teachers, found that beliefs did not significantly change during preservice programs. It was not until students experienced the reality of the classroom in their first years that their beliefs changed. It has been suggested that support programs may assist beginning science teachers in

modifying their beliefs in ways that reinforce the use of student-centered practices (Luft 2001), which leads to the next topic.

Support programs are important for beginning teachers (Huling-Austin 1990, 1992; Huling-Austin and Murphy 1987; Gold 1996; Griffin 1985). Huling-Austin (1990), for example, concluded that support programs can improve the teaching performance of beginning teachers, increase the retention of beginning teachers, promote the personal and professional well-being of beginning teachers, and transmit the culture of the system to beginning teachers. In addition, she suggested that such programs can help beginning teachers to satisfy induction and certification requirements. In a later review of studies on beginning teachers, Huling-Austin (1992) noted a number of factors that corresponded with their success in the classroom. Two salient factors were collegial support and mentoring, which are key components of induction programs.

Although these studies have contributed significantly to the dialogue about the potential of induction programs, they have overlooked the critical aspect of subject-specific support. Luft et al. (2001), in a small study, demonstrated that a science-focused induction program had a greater impact on the practices and beliefs of beginning science teachers than did general induction programs. Specifically, the secondary science teachers in the university–school district support program implemented more student-centered inquiry lessons, held beliefs aligned with student-centered practices, and felt fewer constraints in their teaching than did teachers with no support or those in a general induction program. Collectively, these studies and reviews reinforce the importance of induction programs that are developed in response to the specific needs of teachers, which includes discipline-focused support.

Crafting Induction Programs for Science Teachers

The discussion in the previous section conveyed the complex process of beginning teacher development and suggested areas that should be part of induction programs for science teachers. The following discussion builds on the above-mentioned research by including additional studies that are relevant to the development of induction programs. Specific areas to consider in the development of induction programs are discussed, and guiding questions (Figure 1) are offered to assist those charged with developing induction programs for science teachers.

Program Format

Induction programs for science teachers should be consistent with effective professional development practices. Loucks-Horsley et al. (1998) and Rhoton and Bowers (2001) provide guidance for those charged with planning and designing such programs. Their collective suggestions are grounded in research and practice, and they offer a vision for progressive professional development programs. However, their recommendations should be carefully reviewed and modified appropriately to meet the unique needs of beginning science teachers. This would result, for example, in the design of programs that focus on new teachers' fluctuating beliefs and limited

Figure 1. Guiding Questions in the Development of an Induction Program for Beginning Science Teachers

Component	Questions
1. Program format	Who will oversee and direct the program? What will be the duration of the program (1, 2, or 3 years)? How will the program interface with other efforts to support beginning science teachers? How will teachers learn about the program? What will be their incentive for participating? How will the program be institutionalized? How will ongoing support be provided to the beginning teachers throughout the school year? What will be the specific components of the program (e.g., monthly meetings, electronic communications, new teacher tool kit, observations of beginning teachers)? How do these components support the program goals?
2. Mentor teachers	How will mentor teachers be recruited and selected? What will be the roles and responsibilities of the mentor teachers? How will the roles and responsibilities interface with the various constituents represented in the program? How will mentor teachers participate in their own professional development? How will mentor teachers be compensated for their participation?
3. Linkages	How will collaborative linkages be formed between important constituents? What will be the needed knowledge that each constituent will bring to the program? What will be the incentives for constituents to participate? What feedback will participating constituents receive from the induction program that is relevant to their position in the teacher development process?
4. Program content	What will be the goals of the program? How will the state and national standards be incorporated into the induction program? How will the program content align with the content required in schools? How will the content of the program align with the concerns and development of the beginning teachers? How will the content of the program interface with the entire process of science teacher development?
5. Evaluation	How will the goals of the program be evaluated? How will data be collected and analyzed regarding the different parties in, and affected by, the program? Who will conduct the evaluation? What opportunities will exist during the program to adjust the program? How will feedback be given to those involved in the program?

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classroom experience and that address both the characteristic short-term needs of beginning teachers (e.g., What will I teach tomorrow? Where do I get the tennis balls for my experiment?) and long-term goals for science teacher development (e.g., How well did my students learn that concept? How do I participate in this profession?).

Mentor Teachers

The plethora of literature regarding mentor teachers (e.g., Huling-Austin 1990, 1992; Gold 1996; Capel 1998) attests to the importance of mentors to beginning teachers. Their contributions are complex. Such contributions include providing the new teacher with a colleague to talk or listen to, a source for suggestions on classroom management, a counterpart who assists in planning lessons and locating materials, an experienced educator who helps navigate school policies or procedures, and a facilitator of reflective practice (Abell et al. 1995; Huling-Austin and Murphy 1987; Luft and Cox 2001; Wildman et al. 1992). To carry out these roles effectively, mentor teachers should not be involved in the evaluation of a beginning teacher. When mentor teachers serve as evaluators, they are no longer colleagues who give assistance, but reviewers who are making summative and retention decisions. Ultimately, mentor teachers can play a critical role in purposefully crafted induction programs by facilitating the socialization process of beginning science teachers into their schools and the profession of science education.

Linkages

Induction programs need to create seamless transitions for beginning science teachers as they leave teacher preparation programs and enter the classroom. To ease the disconnect that is often experienced by beginning teachers, induction programs should link faculty and staff from teacher preparation programs with faculty and staff from local school districts. According to Brockmeyer (1998), school district staff can help beginning secondary science teachers with issues such as organization, discipline, classroom routine, local supplies and resources, and school procedures. University faculty and staff, on the other hand, provide beginning teachers with the current research and standards background and with instructional support regarding pedagogy and the enactment of lessons. Such collaborations are important and have been shown to be beneficial to all involved (Gold 1996; Henry 1989; Luft and Patterson, in press; Stroot et al. 1999; Varah, Theune, and Parker 1986). As teacher preparation and school district faculty and staff participate in such programs,

- beginning teachers see the importance and connection of theory and practice,
- faculty of teacher preparation programs receive feedback on their programs and information about current issues in schools, and
- school district participants acquire current information regarding science education reform.

Program Content

While all teachers would benefit by participating in an induction program, beginning science teachers need specialized support that addresses their unique pedagogical and content needs as described by various researchers (e.g., Adams and Krockover 1997; Emmer 1986; Roehrig and Luft, in review; Sanford 1988). This support includes traditional areas that are of frequent concern to all beginning teachers (e.g., classroom management, lesson planning) (Veenman 1984), and it extends to support in planning and managing laboratory instruction, implementing inquiry- and standards-based lessons, and fostering an understanding of the nature of science among students. Furthermore, such support is appropriate for the increasing number of secondary science teachers who do not have adequate science or pedagogical knowledge (Ingersoll 2001). Providing appropriate subject-specific support for science teachers throughout their entire professional development process ensures their ongoing learning and helps them to acquire local, state, or national certification. Our current system, which primarily gives subject-specific support during preservice and inservice years, overlooks a unique opportunity to advance the knowledge of science education in science teachers when it is most critical and in a format that bridges preservice and inservice education.

Evaluation

Effective program evaluation is critical in facilitating the growth of participants. Such efforts need to extend beyond the traditional use of Likert assessments, in which participating teachers indicate their degree of satisfaction with an event on a one to five scale. At the least, the following information should be collected and analyzed during a professional development program: beginning teachers' beliefs about teaching and their behaviors in the classroom, their students' work in the classroom, the instructors' perceptions and experiences, administrators' understanding and participation in the program, and documents regarding the participation and activity of the beginning teachers. This information is then used to provide direction for modification of the professional development program while informing program coordinators, directors, and administrators about the impact of the program. Loucks-Horsley et al. (1998), in their model of professional development design for science and mathematics teachers, stressed the importance of monitoring practitioners throughout a professional development event in order to modify the program to meet participants' changing needs. This process—"set goals, plan, do, and reflect"—should be included in every teacher education program.

Conclusions and Implications

As induction programs are designed and implemented, it is important to consider their limitations as well as their benefits. In this chapter quite a bit has been discussed regarding their potential, which includes providing teachers with subject-specific content and pedagogical support, assistance with the modification of cur-

riculum, emotional support and logistical assistance, and opportunities to reflect on their practice. These benefits contribute to the professional development of a science teacher, and often when the teacher needs it most. However, it is easy for those developing induction programs to envision a greater impact than is realistic. For example, while induction programs can assist beginning teachers in shaping their beliefs and practices, they cannot create significant changes in beliefs, practices, or knowledge. In addition, they cannot directly improve school working conditions, nor are they the panacea for the retention of beginning teachers.

Induction programs are an important component in the professional development of a science teacher. They reinforce practices learned in preservice education and prepare teachers for forthcoming professional development experiences. Furthermore, they have the potential to involve school district and university personnel in the socialization of beginning teachers, which also has an impact on the instructional environment of schools and teacher preparation programs. Ultimately, induction programs are an important and worthwhile investment in our science teaching force.

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